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TEST AND EVALUATION OF FOAM-IN-PLACE FUEL TANK CONTAINER.(U)
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AFPEA PROJECT NO. 79-P7-33

LEVEL II

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See 1473.

TEST AND EVALUATION OF

FOAM-IN-PLACE FUEL TANK CONTAINER

HQ AFALD/PTP
AIR FORCE PACKAGING EVALUATION AGENCY
Wright-Patterson AFB OH 45433

December 1980

NOTICE

ABSTRACT

One single pack, F-100 aircraft, 200-gallon fuel tank foam-in-place (FIP), reusable container fabricated by Instapak, Sealed Air Corporation, Danbury CN 06810 was tested by the Air Force Packaging Evaluation Agency (AFPEA), Wright-Patterson AFB OH 45433. The container was tested IAW Federal Test Method Standard (FTMS) 101B, MIL-STD-810C and MIL-P-116G. Although a crack, with a maximum 1/2" gap, across the bottom section of the container resulted from the temperature shock test, the container passed all of the requirements as specified for this project except the cyclic exposure test. Improvements resulting from this evaluation will be incorporated into the fabrication of two additional prototype containers for the F-4 aircraft, 370 and 600 gallon fuel tanks.

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INTRODUCTION

Previous experiences with FIP containers for F-100, 200 gallon fuel tanks indicated that the concept was feasible for satisfying rough handling requirements, providing extended environmental protection and, consequently, extending inspection cycles and reducing life cycle costs. However, observation of the containers indicated cracking in the 2 pcf rigid foam when lifted by forklifts. Structural integrity for a new design must be such that bending and sagging will not result in cracking of the container's wall or surfaces.

The Air Force Packaging Evaluation Agency (AFPEA) initiated a development project to design and fabricate FIP containers with a load bearing structure within the foam and tie-down provision (Figure 1) for assembled aircraft fuel tanks. Under this project, three FIP, reusable containers will be fabricated by Instapak, Sealed Air Corporation, Danbury CN 06810. One single pack, F-100, 200 gallon fuel tank container was subjected to a complete mechanical and environmental test by AFPEA. The test results are presented in this report. Containers for the F-4, 370 and 600 gallon fuel tanks are chosen for service test because they are most needed in the field for storage of WRM assets.

CONTAINER CONFIGURATION CHARACTERISTICS

The single pack, F-100, 200 gallon fuel tank container (Figure 1) with

Exterior Dimension (L x W x D)	166" x 34" x 41"
Exterior Volume	134 cu. ft.
Tare Weight	328 pounds
Gross Weight	426 pounds

was made of Instapak 200, 2 pcf rigid foam and had rough skin surface and gaps between the container top and bottom (Figure 2 and 3) as received. The joint was patched for a better seal, and the outer skin surface was painted with spar varnish aluminum paint before the test.

TEST PROCEDURES AND RESULTS

Tests were conducted in accordance with Federal Test Method Standard (FTMS) 101B, Military Standard 810C and MIL-P-116G. Table 1 is the outline of the container test plan. During the tests, a test load of 98 pounds assembled, F-100, 200 gallon fuel tank was placed in the container.

1. Rough Handling Test at Ambient Temperature

(a) Cornerwise Drop (Rotational) Test: The cornerwise drop (rotational) test was conducted in accordance with FTMS 101B, Method 5005. A 24-inch drop height was used during the test. Drops were made once to each of two diagonally opposite corners of the base.

Results: Visual inspection revealed no damage to the container.

(b) Edgewise Drop (Rotational) Test: The edgewise drop (rotational) test was conducted in accordance with FTMS 101B, Method 5008. A 24-inch drop height was used during the test. Drops were made once to each end of the container.

Results: Visual inspection revealed no damage to the container.

(c) Pendulum-Impact Test: The pendulum-impact test was conducted in accordance with FTMS 101B, Method 5012. The impact was at seven feet per second. Both ends of the container were impacted.

Results: Visual inspection revealed no damage to the fuel tank and container. However, after the first impact on one end, the container top slipped 3" (Figure 4), and an indentation was observed on the container bottom. For development purposes, edge protectors were placed between the closure straps and the container top during closure. After impact on the opposite end, the container top slipped 1 1/2" and a layer of foam, approximately 2" x 12" x 2" thick, was peeled from the bottom edge (Figure 5).

2. Superimposed Load Test at Ambient Temperature

The superimposed load test was conducted in accordance with FTMS 101B, Method 5016. A load of 3200 pounds was applied on the container and kept constant at that loading for one hour. Measurements were made at the four corners and mid-center of the sides for compression set (Figure 6).

Results: At the end of the test, a maximum of 1/8" compression was noted.

3. Temperature Shock Test

The temperature shock test was conducted in accordance with MIL-STD-810C, Method 503.1, except that temperatures were at -40°F and 140°F.

Results: After the first cycle of exposure at 140°F for 4 hours and -40°F overnight, visual inspection revealed no damage to the container. However, at the end of the second cycle of exposure at 140°F for 72 hours and -40°F for 24 hours, a wedge-shaped crack generated across a cross section of the container bottom located 36 1/2" from one end of the container (Figures 7-9). The container was not subjected to the third test cycle.

4. Rough Handling Test at -40°F

Test No. 1 was repeated except that the temperature was at -40°F.

Results: Visual inspections revealed no further damage to the container after cornerwise drops, edgewise drops and pendulum impacts. However, the container top still slipped 2 1/2" after the first impact and 1 3/4" after the second impact.

5. Superimposed Load Test at -40°F

Not performed.

6. Rough Handling Test at 140°F

Test No. 1 was repeated except that the temperature was at 140°F.

Results: The crack generated during the thermal shock test was closed after exposure at 140°F for 23 hours. Visual inspections revealed no damage to the fuel tank or container. However, the container top slipped 2 3/4" after the first impact and 2" after the second impact. At the end of the test, the crack from the temperature shock separated again.

7. Superimposed Load Test at 140°F

Test No. 2 was repeated except that the temperature was at 140°F.

Results: Measurements were made at the four corners and mid-center of the sides for the compression set. A maximum of 1/16" compression was noted at mid-center of the sides.

8. Vibration Test at Ambient Temperature

The vibration (repetitive shock) test was conducted in accordance with FTMS 101B, Method 5019. The amplitude of the vibration was 1" (double amplitude), and the frequency was 4.3 Hz during the 2-hour test.

Results: Visual inspection revealed no damage or failures in the container.

9. Mechanical Handling Test at Ambient Temperature

The mechanical handling test was conducted in accordance with FTMS 101B, Method 5011.

Lifting and Transporting by Forklift	Para 6.2
Undersling Handling	Para 6.3.1
Sling Handling with Attachments	Para 6.3.2
Pushing by Forklift	Para 6.4
Towing	Para 6.6

Results: The container was very stable while lifting or transporting by forklift, undersling handling, and sling handling with attachments. During the pushing test, some foam was left on the concrete surface but it was not excessive. However, a piece of foam (about 3" x 15" x 3") was peeled from the end skid while towing by forklift.

10. Modified Cyclic Exposure Test

The cyclic exposure test was conducted in accordance with MIL-P-116G, para 4.4.5.2 except that the water was sprayed at 5 in/hr, including 15 minutes of 40 MPH wind at the end of each hour.

Results: At the end of the three-day test, moisture was observed on the outer surface of the polyethylene material (2 mil), which was wrapped around the fuel tank, and some droplets were noted on the tank (Figure 10). Also, approximately 1/4 cup of water was collected on the outer surface of the polyethylene material at one corner of the tank (Figure 11). After removing the fuel tank from the container bottom, tears were noted in the polyethylene material which may have been caused from shifting of the tank during testing or handling. A pool of water approximately 1/2" deep and 4 1/2' long was found inside the container bottom (Figure 12).

DISCUSSION

Although there was a crack generated during the temperature shock test, the FIP fuel tank container passed all of the requirements as specified for this project except the cyclic exposure test. However, this is the first of three FIP fuel tank containers to be fabricated in the development contract. The lessons learned from this test will be used to improve the fabrication method and procedures for the next two containers designed for the F-4, 370 and 600 gallon fuel tanks.

RECOMMENDATIONS

Following are improvements to be incorporated into the fabrication of the second and third prototype containers for the F-4, 370 and 600 gallon fuel tanks during the development contract with Instapack, Sealed Air Corporation:

1. The bed-frame type clamps will be used in the internal load-bearing structure to allow longitudinal displacement for temperature shock adjustment.

2. A mold release will be used on walls to improve the skin surface of the container.

3. Three drainage pipes will be added in the container bottom.

4. Available space inside the container for the fuel tank will be made about 1" bigger than the fuel tank to allow for shrinkage adjustment during the chemical curing process. This will also improve the seal between the top and bottom of the container.

5. The closure joint surfaces between the container top and bottom will be at a 45° angle, instead of a 30° angle. Efforts will also be made to smooth the joint surfaces to improve the seal between the top and bottom.

6. The embedded strapping will be replaced by regular banding with load spreaders on the edges of the container. Hopefully, this will tightly secure the container top and bottom to prevent slippage during the impact test.

AIR FORCE PACKAGING EVALUATION AGENCY (Container Test Plan)					AFPEA PROJECT NUMBER 79-P7-33	
CONTAINER SIZE (L X W X D) INT.	EXT.166"x34"x41"	WT (GROSS) 426#	WT (ITEM) 98#	CUBE 134 ft^3	QUANTITY 1	DATE 19 Nov 1980

ITEM NAME	MANUFACTURER
F-100, 200 gallon fuel tank	Instapack

CONTAINER NAME	CONTAINER COST
Foam-In-Place Container	$1,334.00

PACK DESCRIPTION
Foam-In-Place split pack configuration for assembled fuel tank.

CONDITIONING
Rough skin to be painted; gaps along the joint to be patched.

TEST NO.	TEST METHOD	PARAMETERS	ORIENTATION	INSTRUMENTED
1	Rough Handling Test at Ambient Temperature			
(a)	FTMS 101 Method 5005	24 inch drop height	Once to each of two diagonally opposite corners of base	N/A
(b)	FTMS 101 Method 5008	24 inch drop height	Once to each end of container	N/A
(c)	FTMS 101 Method 5012	7 FPS impact	Both ends, both sides	N/A
2	Superimposed Load Test at Ambient Temperature			
	FTMS 101 Method 5016	3138 pound load	one hour, superimposed	N/A
3	Temperature Shock			
	MIL-STD-810 Method 503.1	Except that temperatures at $-40^{\circ}F$ and $140^{\circ}F$		N/A
4	Repeat Test No. 1 at $-40^{\circ}F$			
5	Repeat Test No. 2 at $-40^{\circ}F$			
6	Repeat Test No. 1 at $140^{\circ}F$			
7	Repeat Test No. 2 at $140^{\circ}F$			

COMMENTS:

PREPARED BY:	APPROVED BY:
Shui-Nan Chuang *Shui-Nan Chuang*	*Ralph Zynda* RALPH ZYNDA, Chief, Design Division, Air Force Packaging Evaluation Agency

AFALD FORM 4 PREVIOUS EDITION WILL BE USED

AIR FORCE PACKAGING EVALUATION AGENCY (Container Test Plan)					AFPEA PROJECT NUMBER	
CONTAINER SIZE (L X W X D) INT.	EXT.	(GROSS) WT	(ITEM)	CUBE	QUANTITY	DATE
ITEM NAME			MANUFACTURER			
CONTAINER NAME				CONTAINER COST		
PACK DESCRIPTION						
CONDITIONING						

TEST NO.	TEST METHOD	PARAMETERS	ORIENTATION	INSTRU-MENTED
8	Vibration Test at Ambient Temperature			
	FTMS 101 Method 5019	One inch double amp. 3-5 Hz. 2 hours	As required by test	N/A
9	Mechanical Handling Test at Ambient Temperature			
	FTMS 101 Method 5011 Proc. 6.2, 6.3, 6.5 and 6.6	Lifting and Transporting by Forklift	100 feet	N/A
		Undersling Handling	Suspend 2 minutes	
		Hoisting with sling	Suspend 2 minutes	
		Pushing by Forklift	35 feet in 85 seconds	
		Towing	100 feet in 23 seconds	
10	Modified Cyclic Exposure Test			
	MIL-P-116 Para 4.4.5.2	Except that water spray 4$\pm$1 inch/hr and to include 15 minute 40 MPH in each hour for 4 hours		N/A

COMMENTS:

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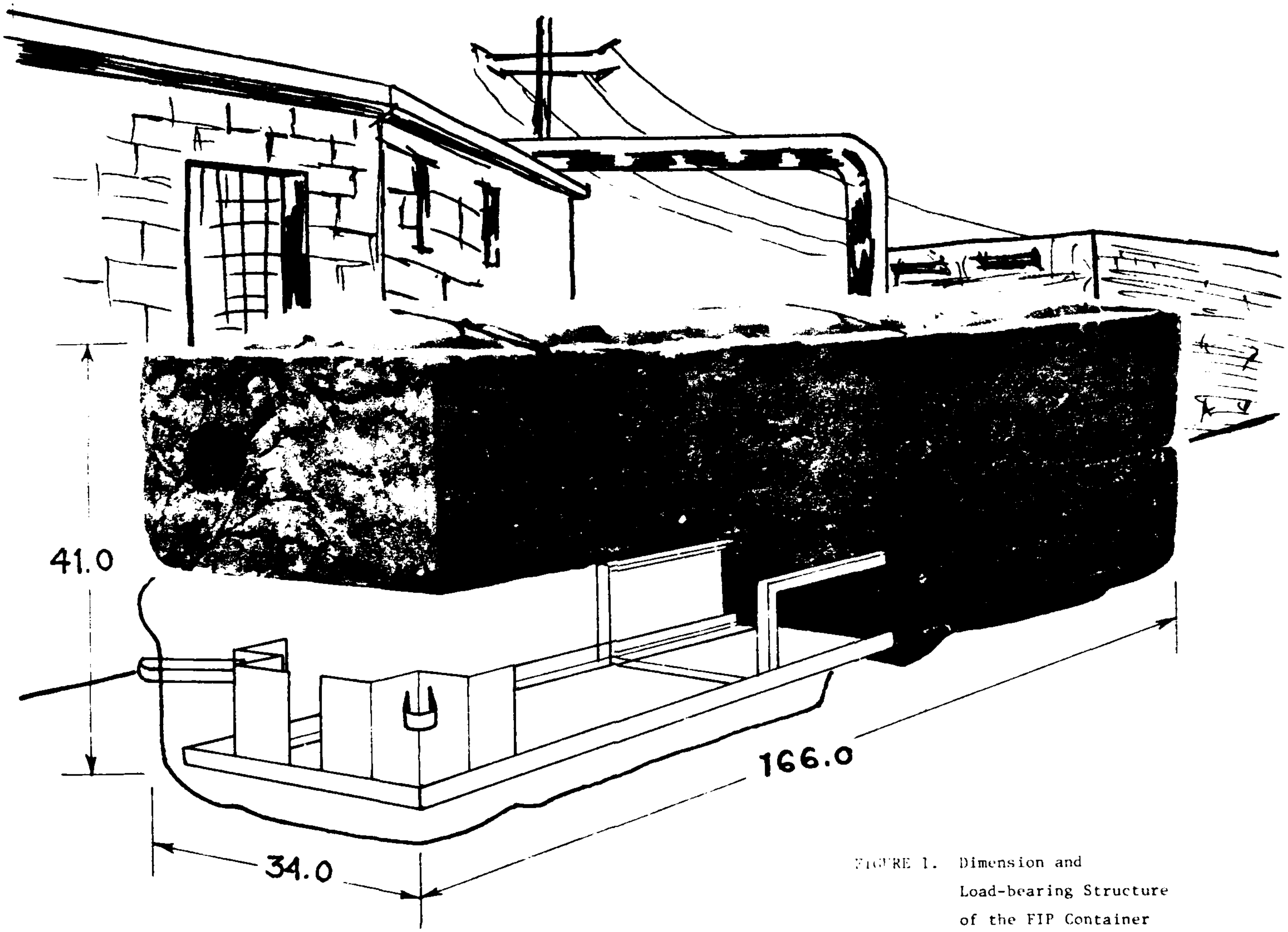

FIGURE 1. Dimension and Load-bearing Structure of the FIP Container

FIGURE 1. Dimension and Load-bearing Structure of the FIP Container

FIGURE 2. General Appearance and Rough Skin of FIP Container as Received

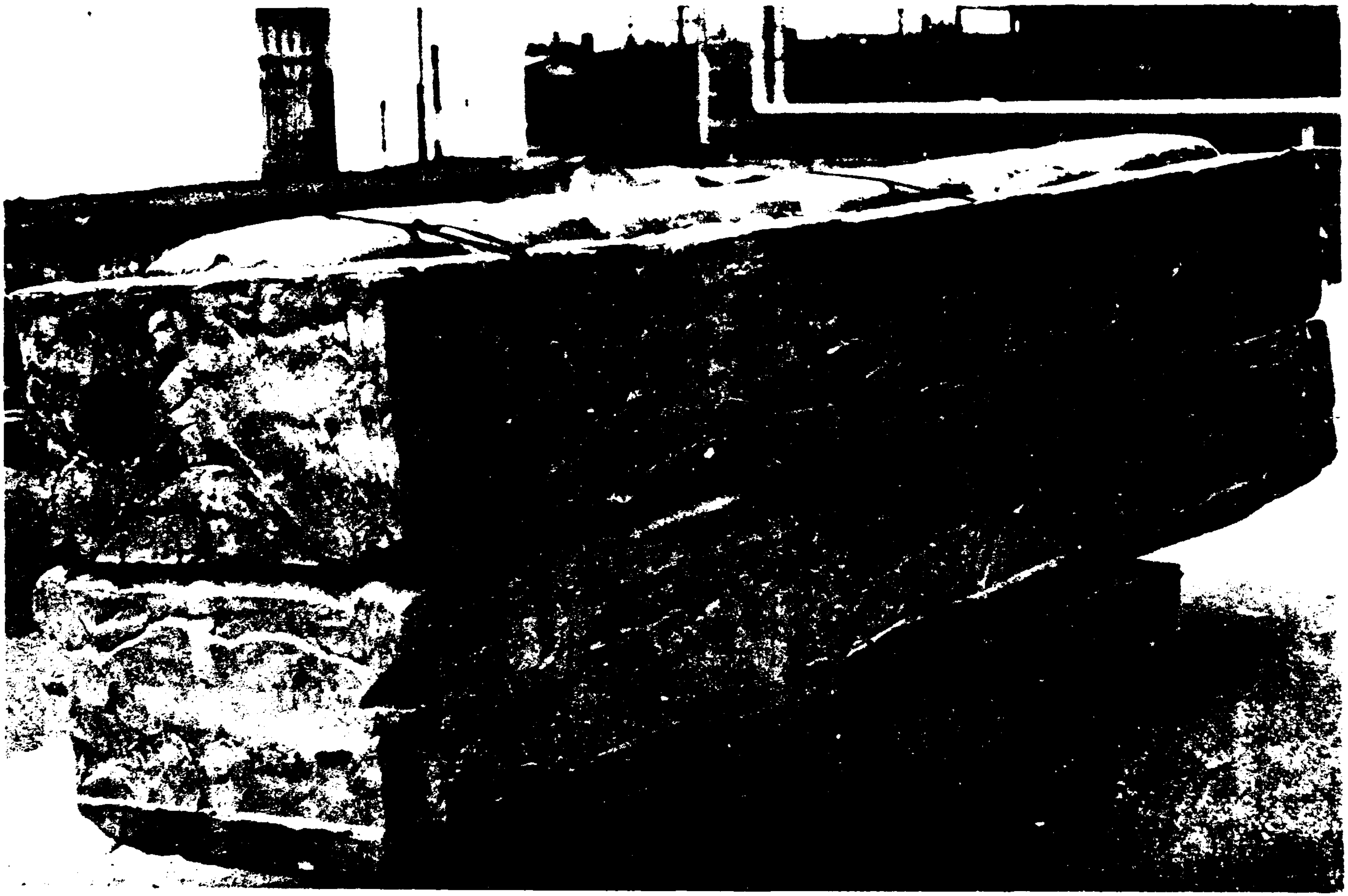

FIGURE 3. Gaps between Container Top and Bottom as Received

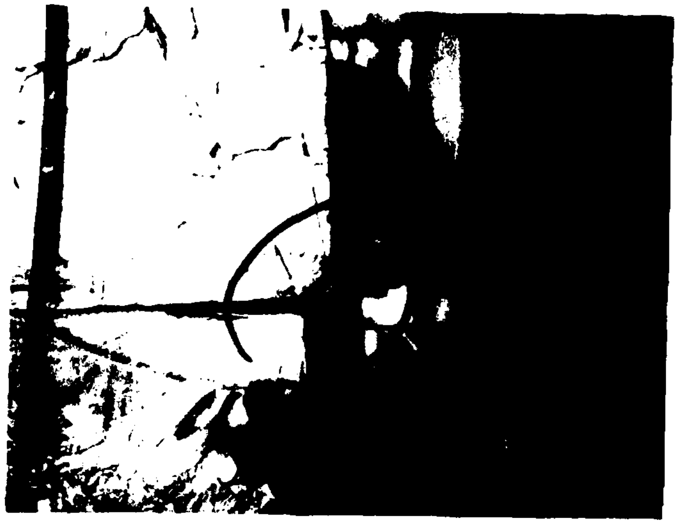

FIGURE 4. Container Top Slipped 3" after First Pendulum-Impact Test

FIGURE 5. A Layer of Foam Peeled after Second Impact Test

FIGURE 6. Superimposed Load Test

FIGURE 7. Top View of Crack Due to Temperature Shock

FIGURE 8. Side View of Crack Due to Temperature Shock

FIGURE 9. Side View of Crack Due to Temperature Shock

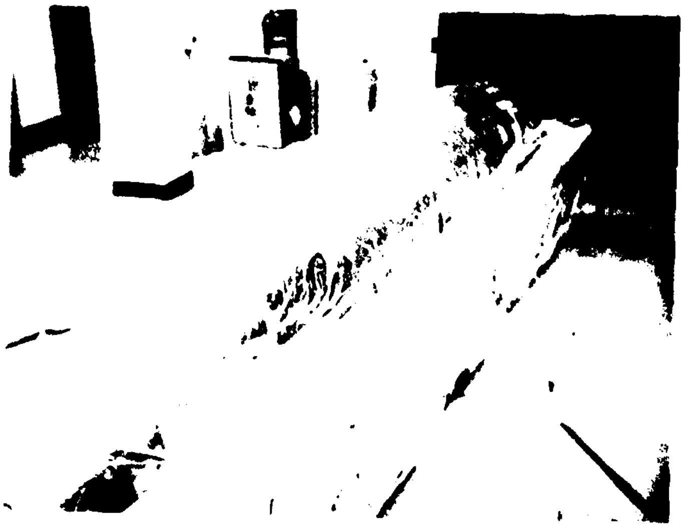

FIGURE 10. Moisture Collected on Outer Surface of Polyethylene Material after Cyclic Exposure Test

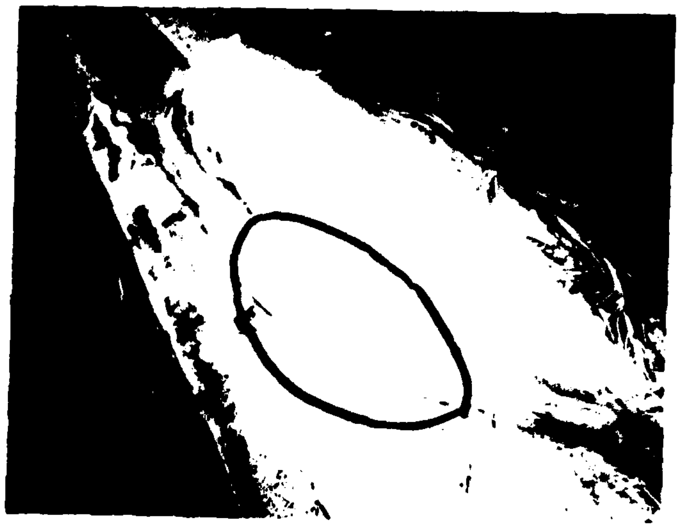

FIGURE 11. Water Collected on Outer Surface of Polyethylene Material at One Corner of the Tank

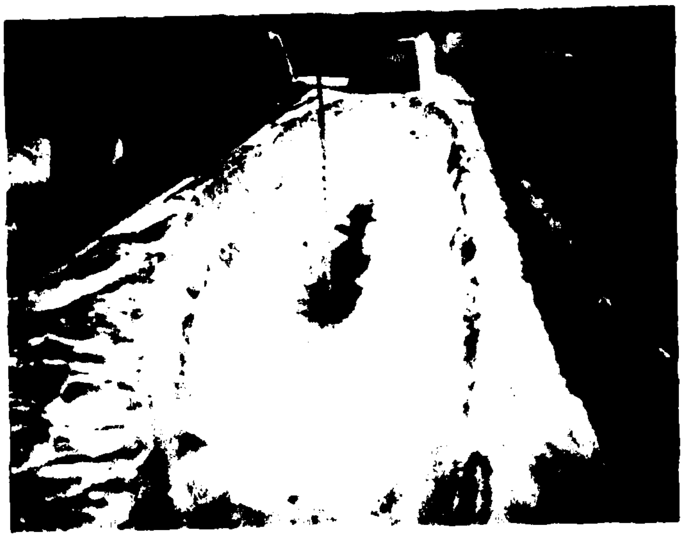

FIGURE 12. Half-Inch Deep Pool of Water Found Inside

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)
One single pack, F-100 aircraft, 200-gallon fuel tank foam-in-place (FIP), reusable container fabricated by Instapak, Sealed Air Corporation, Danbury CN 06810 was tested by the Air Force Packaging Evaluation Agency (AFPEA), Wright-Patterson AFB OH 45433. The container was tested IAW Federal Test Method Standard (FTMS) 101B, MIL-STD-810C and MIL-P-116G. Although a crack, with a maximum 1/2" gap, across the bottom section of the container resulted from the temperature shock test, the container passed all of the

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BLOCK 20. ABSTRACT (continued)

requirements as specified for this project except the cyclic exposure test. Improvements resulting from this evaluation will be incorporated into the fabrication of two additional prototype containers for the F-4 aircraft, 370 and 600 gallon fuel tanks.

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